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Mushrooms as a Sustainable Protein Source in Climate-Resilient Agriculture

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ABSTRACT

Mushrooms, a sustainable protein source, have a bright future as they can significantly improve food security. They are environmentally friendly because they use fewer resources for cultivation and use agricultural waste as substrate. It contributes to human health and nutrition by providing a rich nutritional profile. It's farming with regenerative agricultural models that promote rural livelihood, lower greenhouse gas emissions, and improve soil health through low-cost production and value addition. The potential of mycoprotein innovation and climate-smart food systems is posing increasing challenges in post-harvest management and technical expertise. Mushrooms, with the objective of climate resilience and sustainable development, offer a nutrient-dense and eco-friendly protein source.

Keywords: Mushroom production, Climate-resilient agriculture, sustainable protein source

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Introduction

Food security is an emotive issue that cannot be assigned to a single Geography or category, i.e., geographic location, education, income, or demography. According to FAO/UNICEF defined characteristics of food security are food availability, food consumption, which depend on cultural norms and dietary practices, practical and financial food access, and food stability [1]. The most ancient evidence Humans have been eating wild edible fungi (WEF) during the Upper Paleolithic period, around 18,700 years ago. The evolution of all life on Earth has been altered. As saprotrophs, parasites, mycologist, or symbiotic, they have been significant to the administration and constitution of natural ecosystems worldwide [2]. By 2050, it poses a significant challenge to food security, expected to exceed 9 billion, the global population. it is imperative to produce effective and more sustainable food than animal protein, such as insect, plant sources, algae, and edible mushrooms [3]. Proteins from edible mushrooms meet the necessary nutritional needs and amino acid profile less expensive compared to those from animals and plants. According to the Food and Agriculture Organization of the United Nations, in 2018, approximately 9 million tons of mushrooms were produced globally. Mushrooms are regularly maintained species of oyster mushrooms (oyster mushrooms), white button mushrooms (Agaricus bisporus), and golden needle mushrooms (Flammulina Velutipes). The largest and most widely consumed fungus worldwide is Agaricus bisporus, followed by Lentinus edodes and Pleurotus species [4]. Mushrooms are a kind of fungus that provide many kinds of high-nutrient content and health advantages and are high in protein, vitamins, minerals, and fiber, making them an indispensable addition to the human diet [5]. The nine essential amino acids — methicillin, threatening, leucine, Phenobarbital, saline, isoleucine, histidine, arginine in Mushrooms and due to their nutrient-rich status like carbs (50.90–81.00%), minerals, fat (1.50–6.50%), protein (8.10–30.10%), calories, vitamins, and dietary fiber [6]. Farming of various edible mushrooms depends on the environment and industry in various types of locations (hangars, greenhouses, etc.), and technologically and technically ensures the measurement of environmental factors, including CO2, temperature, and humidity, for the growing process of mushrooms. For measuring environmental factors, various types of need different kind of sensors, like (1) optical sensors to measure soil moisture, (2) effective field fertilization

These are measured using location sensors, (3) Soil pH, salinity, are measured using magnetic sensors (4), Petrochemical sensors that measure like H+, K+, (5) air flow sensors

(6) air flow sensors (7) Acoustic sensors to identify pests in the area where mushrooms are grown [7]. Mushrooms are essential to human health, one of the most nourishing foods, safest, and healthiest. mushrooms are useful in treating medical conditions, including the kidneys, lungs, and ears, and frequently correspond with the "doctrine of signatures. Nowadays, edible mushrooms are useful in biopharmaceuticals and dietary supplements. The medicinal potential, ethnomycological context, uses of the mushroom Helium, role in well-being, sustainable development, and health [8].

Nutritional Profile of Mushrooms:

Edible mushrooms do not take up a lot of space to thrive, are high in protein, and are rich in minerals and low in fat, cholesterol-free, and are comprised of unsaturated fatty acids. Carbohydrates, Nutritive sugars make up 2% to 10% of the dry weight. carbohydrates about 60% of their total dry weight. Mushrooms are a rich source of nutrients, like calcium, magnesium, phosphorus, and potassium are quite high among them. In combination with traces of elements like molybdenum, copper, selenium, and iron [9]. Mushrooms are a good source of high-quality fiber, both soluble and insoluble. Soluble fibers like pectin and beta-glucan can lower cholesterol levels and reduce the chance of stroke and heart disease—insoluble fibers, including glucagon, lignin, cellulose, and chitin [10].

Environmental Benefits:

The mushrooms are vital to human nutrition, with high vitamin, mineral density and protein. The environment affects mushroom production; the simulation and modeling of humidity, irrigation control, and temperature protect the production [11]. Mushrooms are an important source of protein and diet, but knowledge about their environmental impact and value chain is still lacking. thus, a complete understanding of the environmental consequences of mushroom cultivation and comparisons between geographical areas and production techniques for mushroom production development [12].

Economic Opportunities for Farmers: The mushrooms most promising resources that help to bring in money and lower poverty, improving socioeconomic growth. The mushroom industry creates direct and indirect job opportunities in the areas of farming and marketing. Research on the economics of the average BCR was 1.55, gross margin was BDT 38790, and net return was BDT 22888, and 3.6 to 4.25 high BCR values of oyster mushrooms on various kinds [13]. It provides family members with vitamins, nutritious food, high protein content, environmental protection contributions, and medical advantages, and gives high profit with low investment in oyster mushroom cultivation [14]. Just in the Khyber Pakhtunkhwa province of Pakistan, 60% of the nation's overall output yearly productivity was 500 tons in the District Swat, nearly Pk-Rs. 50 million in total revenue, both male and female, there are 289,000 Rs [15].

Challenges in Mushroom Production: During cultivation and marketing, farmers who grow mushrooms face several problems, such as a scarcity of technology, a lack of cultivation houses, a lack of a local market, good mushroom spawn, warehouses, and advertisement [16]. Various mushroom species confront different problems and opportunities with climate change

due to variations in genetic characteristics, environmental requirements, and nutritional supplies, and the main challenges are growing operating demands and the availability of substrate in growth facilities [17]. Fungal biotechnology faces challenging states in functional genomics investigations because some genetic sequences are speculative. Further, there is a limited and poor grasp of fungal biology and synthetic biology methods. The cultivation, cloning of fungal strains, and identification can still be improved [18]

Conclusion: The mushrooms are an auspicious source of protein and a perfect ingredient for the future food system. They have the capacity to cultivate on agricultural waste with minimal land use and a minimal environmental footprint. It is an effective alternative to traditional sources of protein, which are damaging to the environment and resource-intensive. Further, using the discarded mushroom substrate in the production of mushrooms facilitates soil health and the economy. Training of farmers and enhanced research, alongside commercialization of mushrooms and policy facilitation, will play a crucial role in using this protein source as a climate-sustained solution to food in the future.

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